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ABSTRACT

In this paper, the bibliographical references in five core entomology journals are examined for citation accuracy in order to determine if the error rates are similar. Every reference printed in each journal's first issue of 1992 was examined, and these were compared to the original (cited) publications, if possible, in order to determine the accuracy of the reference. Percentage of total errors was calculated for each journal, and the errors were sorted by type, such as an error in an author's name or in pagination. The study focused on the following research questions: (1) "What percentage of citation errors typically occur in the most cited entomology periodical literature? Overall, are the references in these entomology journals more or less accurate than those in medical and library science journals?"; (2) "What types of errors typically occur, and how do they compare with results of other studies?"; and (3) "What types of publications do authors make the most mistakes in citing?" It was found that, on average, 30 percent of citations in the journals contained one or more errors. Most of the errors appeared in journal article titles, with article author names and pagination errors being the second and third most frequent. Some types of errors occurred very infrequently; these included: journal title, volume, page and year omissions, and book publication year omissions. Out of the 49 articles in the 5 journal issues examined, only 3 articles had completely error-free reference lists. (Contains 24 references.) (AEF)

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ED 389 341

ACCURACY OF REFERENCES IN FIVE ENTOMOLOGY JOURNALS

A Master's Research Paper submitted to the
Kent State University School of Library and Information Science
in partial fulfillment of the requirements
for the degree Master of Library Science

by

Cynthia Kristof

May, 1995

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Studies of the accuracy of bibliographical references have been done in medical and library science journals. Every study performed so far has detected errors, such as incorrect volume or page numbers, inaccurate article or journal titles, and misspelled authors' names, in the bibliographical references examined. Bibliographical reference accuracy is essential to the success of scholarly communications, bibliometric studies, citation indexes, databases, and the interlibrary loan and document delivery processes. However, such a study of the bibliographical references in entomology periodicals has not yet been published. What types of reference errors occur in citations in entomology journals? How do these errors compare by rate and by type? What types of publications do authors make the most mistakes in citing? In this study, the bibliographical references in five core entomology journals are examined. Every reference printed in each journal's first issue of 1992 was examined, and these were compared to the original (cited) publications, if possible, in order to determine the accuracy of the reference. Percentage of total errors was calculated for each journal, and the errors were sorted by type, such as an error in an author's name or in pagination. It was found that, on average, 30% of citations in the entomology journals studied contained one or more errors.

TABLE OF CONTENTS

LIST OF TABLES....iv

ACKNOWLEDGEMENTS....v

INTRODUCTION....1

LITERATURE REVIEW....2

RESEARCH OBJECTIVES AND HYPOTHESIS....9

METHODOLOGY....10

RESULTS AND DISCUSSION....16

SIGNIFICANCE....25

REFERENCES....26

LIST OF TABLES

Table 1: Unverifiable Citations.....15

Table 2: Entomology Journals Studied, Citations, and Errors.....17

Table 3: Types of Citation Errors Found.....18

Table 4: A Comparison of Citations Accuracy Studies.....22

Table 5: Comparison of Citations to Journal Articles with Citations to Books.....23

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Introduction:

The problem of inaccurate bibliographical references is one that has existed for as long as authors have cited other authors. The most famous case of an inaccurate bibliographical reference citation is the case of "Dr. O. Uplavici." "O uplavici" actually refers to amoebic dysentery; however, an article written by Czech medical professor Jaroslav Hlava in 1887 on amoebic dysentery, got mistakenly attributed to a "Dr. O. Uplavici." This error was repeated in various forms for years until Clifford Dobell wrote the story of this famous foul-up in 1938 (Dobell, 1938). This humorous example of bibliographical citation error illustrates two things: one, that citation error occurs, even when an article's author is a respected researcher, and it is more common than one would think; and two, that citation error can self-perpetuate, become embarrassing, and can hinder scholarly communications.

Indeed, several authors have pointed out that bibliographical references are used for many things. References are often "called upon to locate papers" not yet indexed (Place, 1916, p. 697); they "provide a method of evaluating the article; [and] assist in assessing an author's credibility" (Foreman and Kirchhoff, 1987, p. 177). Furthermore, accurate references are necessary to the success of bibliometric studies, citation indexes and databases, and the interlibrary loan and document delivery processes (Pandit, 1993). Many respected authors do not actually check the primary document before citing it, but rather take "a reference from another's bibliography as though it were thereby Gospel truth itself" (Place, 1916, p. 699). This explains why "Dr. O. Uplavici" was listed in the 1910 Index-Catalogue of Medical and Veterinary Zoology as having received a degree!

At present, studies of citation accuracy have been performed mainly in the fields of medicine and library science. Studies in the fields of education, psychology, social sciences, business, and other areas are lacking. One such area is

the biological sciences. This study examined five core entomology journals for citation accuracy in order to determine if the error rates are similar.

Literature Review:

In Doms' 1989 study of five dental journals, he defined two categories in which all references may be divided: "correct or incorrect. A correct reference was a reference that was identical to the source. An incorrect reference was a reference that deviated from the source" (p. 442). Errors, in Doms' study, "involved names or initials of authors, title of article, name of journal, volume number, year of publication, page numbers, punctuation, [and] spelling..." (p. 442). Yankauer (1990) defines citation errors as, "errors of commission or omission in the printing of the reference" (p. 38). Pandit states that errors "focus on the citations themselves and exclude the extent to which authors correctly quoted a text or acknowledged an intellectual debt" (p. 185).

When defining what would be counted as an "error", all studies have looked for common elements, such as author, journal title, volume, and year, that journals usually require for contributing authors' bibliographical references. For example, Key and Roland (1977) defined seven categories of errors: author, title, journal, volume, pagination, year, and publisher. If an author happened to give "superfluous information" (p. 136), such as the month of publication, than this was deleted and not counted as an error. Deviations from the stylistic requirements of the journals, such as the order of the volume, pagination, and year, or incorrect Index Medicus abbreviations, were not counted as errors, either. Poyer (1979) chose not to include an error category for article title, since "many journals do not require titles, and if there was a mistake (for example, spelling or omission), it would be impossible to decide how this would affect the potential use of the cited document"

(p. 397). Pandit included five error categories: name of the journal/book, title of the work, author/editor, volume and issue number, pagination, and year, and publisher. Pandit's study differs from most previous studies in that she included wrong and missing issue numbers as errors "except in the case of journals which follow the policy of including seasons or months instead of issue number" (p. 190). She "compensated for the fact that for journals using the American Psychological Association (APA) style or similar styles, the issue number is not used unless each issue begins with page 1" (p. 190). No studies thus far have addressed any other possible categories of errors, such as monographic series titles.

Benning and Speer maintain that library science literature contains fewer "major" errors, which "prevent immediate identification of the source of the reference," (de Lacey, 1985, p. 884) than does medical literature. Many studies in both medicine and library science discuss "major" and "minor" errors and the differences between the two. Doms (1989) defines "minor" errors as "omissions that did not prevent the location of the article, and included: paraphrased or incomplete article titles, incorrect author initials, or an error in the last page number of an article" (p. 442). Doms defines "major" errors as "references that prevented immediate location of the article cited, and included: incorrect journal titles, article titles, author and citations such as wrong volume, issue, year, and first page numbers" (p. 442). Many other studies of both medical and library science literature have categorized citation errors as either "major" or "minor" (Benning and Spear, 1993; de Lacey, Record, and Wade, 1985; Eichorn and Yankauer, 1987; Evans, Nadjari, and Burchell, 1990; Foreman and Kirchhoff, 1987; Pope, 1992; Putterman and Lossos, 1991; George and Robbins, 1994; Goldberg, Newton, Cameron, Jacobson, Chan, Bukata, and Rakab, 1993; Hinchcliff, Bruce, Powers, and Kipp, 1993; and Nuckles, Pope, and Adams, 1993). However, Pandit's study does not classify errors in terms of

"major" or "minor," nor do some other studies (Key and Roland, 1977; Stull, Christina, and Quinn, 1991; and Poyer, 1979). Sweetland (1989, p. 296) points out that:

> ...a 'slight misspelling' in the author's last name is a major error for the user of the ISI citation indexes, where this name is the primary access point, while it is trivial if the user is looking up the reference in the actual journal.

Most studies which chose to classify errors as "major" or "minor" categorize name misspelling errors as "minor." Hinchcliff, Bruce, Powers, and Kipp (1993) classified name misspelling errors as "major" however, noting that they "would likely impede the rapid, computerized retrieval of the cited material or had the potential to obscure the identity of the author(s)" (p. 398). Goodrich and Roland state in their 1977 article that they did not "attempt to make value judgments" by assigning such labels as "serious" and "trivial"; they say that "most of the errors they found were sufficient to require the expenditure of extra time to resolve the discrepancy" (p. 19).

Many studies have selected journals for study because of the journals' subject area and scope; however, a few studies have made an attempt to select "core" journals in a subject area. Poyer, in his 1979 study of significant science journals, chose to study 34 of the "206 most cited and 206 high-impact journals," (p. 396) as judged by Eugene Garfield in his 1976 article, "Significant Journals of Science," (Nature 264: 609-15). Pope (1992) attempted "to cover several of the subfields of study within librarianship and of the divisions of the American Library Association" (p. 240) in choosing her ten library science journals. Pandit (1993) selected the journals for her study by consulting "the ranked list of journals in ISI's Journal Citation Reports and selected studies that have identified core journals" (p. 189).

Several studies thus far have used similar sampling techniques when

choosing which bibliographical references to examine in the journals studied. De Lacey, Record, and Wade (1985) examined fifty references, chosen by random numbers, out of the first issues in 1984 of the journals they chose to study. They examined quotations from "original articles, reviews, leading articles, and correspondence" (p. 884). Eichorn and Yankauer (1987) examined fifty randomly chosen references to journal articles only, from the May 1986 issues of the journals they chose. Doms (1989) studied 500 randomly selected references from the March 1987 issues of chosen dental journals. Evans, Nadjari, and Burchell, in their 1990 study, similarly chose fifty random references from the August 1987 issues of surgical journals. Pope, in her 1992 study, examined ten references each from the first 1991 issues of ten library science journals. Benning and Speer (1993) examined "all 555 references found in the articles in the final 1989 issues" (p. 56) of the library sciences journals they studied. Finally, Nuckles, Pope, and Adams, in their 1993 study of ten dental journals, randomly selected thirty references from the January 1991 issues (p. 28).

All studies thus far have made an attempt to verify references directly, by comparing the published citation against the original source. For Pandit's (1993) study, this proved wholly successful. When comparison with the original source was impossible, usually due to the researchers' libraries not containing the cited documents, researchers generally took one of two approaches. Many studies made an attempt to obtain the either a hard copy of the item or a photocopy through standard interlibrary loan (McLellan, Case, and Barnett, 1992; Evans, Nadjari, and Burchell, 1990; de Lacey, Record, and Wade, 1985; and Hinchcliff, Bruce, Powers, and Kipp, 1993). De Lacey, Record and Wade (1985) "classified as unverifiable" (p. 884) any item that could not be obtained through interlibrary loan. Other studies opted to utilize indexes, databases, or other similar sources, such as union lists and Books

in Print to verify references when no hard copy or photocopy was available (Foreman and Kirchhoff, 1987; Poyer, 1979; Boyce and Banning, 1979; Key and Roland, 1977; and Doms, 1989; Benning and Speer, 1993; McLellan, Case, and Barnett, 1992). Pope (1992) points out that "an index has the potential to be as unreliable as the citations themselves" (p. 241), although four of the references she examined were verified using an index. Three studies did not include references for which the original source was not owned by the library (Goodrich and Roland, 1977; Putterman and Lossos, 1991; and Eichorn and Yankauer, 1987). Only two studies classified unverifiable references as erroneous (Doms, 1989; and Pope, 1992).

The results of the bibliographical citation studies in medicine have been surprising, and remarkably similar. One of the first studies, by Goodrich and Roland in 1977, found that among ten respected medical journals, 29% of bibliographical references studied were found to be erroneous. A study of medical and other science journals by Poyer in 1979 showed that out of 2,448 references verified, 466 errors were found, which involved 367 references (15% of all contained at least one error). De Lacey, Record, and Wade, in their 1985 study of six medical journals, found that citation error rates in the journals studied ranged from 8% to 46%, averaging 24% overall. A 1987 study of nursing journals by Foreman and Kirchhoff found that in clinical nursing journals, 38.4% of cited references were erroneous, and that in nonclinical nursing journals, 21.3% of cited references were inaccurate. In Doms' 1988 survey, it was found that 42% of the references examined were incorrect. A study of four anesthesia journals, by McLellan, Case, and Barnett in 1992, found that 50.5% of references contained at least one error. A study of three public health journals by Eichorn and Yankauer found that, overall, 31% of contained either a "major" or "minor" error. A study of surgical journals by Evans, Nadjari, and Burchell showed an overall error rate of 48%. A study of veterinary

medicine journals by Hinchcliff, Bruce, Powers, and Kipp in 1993, revealed an error rate of 30%. Stull, Christina, and Quinn, in their 1991 study of Research Quarterly for Exercise and Sport, found that 47% of that journal's examined citations were erroneous in some way. Goldberg, Newton, Cameron, Jacobson, Chan, Bukata, and Rakab's 1993 study of emergency medicine literature revealed an average error rate of 28%. A survey of ten dental journals by Nuckles, Pope, and Adams (1993), found that 21% of citations were incorrect. George and Robbins' 1994 study of the dermatologic literature showed that 41% of the verified references contained at least one error. Apparently the situation is similar overseas; a study of the two major Israeli medical journals in 1991 by Putterman and Lossos revealed that only two-thirds of references examined were error-free (33% contained errors).

The overall situation is only slightly better for the field of library and information science, which is surprising since librarians are often acquainted with the consequences of inaccurate references. A 1979 study by Boyce and Banning which examined references in the Journal of the American Society for Information Science and Personnel and Guidance Journal showed that references in the former contained 13.6% total errors, and references in the latter contained 10.7% total errors. A 1992 study by Pope of ten library science journals revealed that 30% of bibliographical references contained either "major" or "minor" errors. Pandit's 1993 study of five library science journals showed that out of 1,094 references, 223 errors were detected in 193 of the references (18% of the references contained at least one error). Finally, Benning and Speer's 1993 comparison of library literature (Bulletin of the Medical Library Association, Library Resources and Technical Services, and Library Trends) with medical literature (studies by de Lacey, Evans, and Eichorn), found that 29% of examined references in library science journals contained either a "major" or "minor" error.

Some journals, such as Archives of Physical Medicine and Rehabilitation and Library Trends, have review staff who check the accuracy of references in articles submitted for publication. Key and Roland (1977) examined 129 articles accepted for publication by the Archives of Physical Medicine and Rehabilitation. They found that 54% of the 1,867 references examined were incorrect, and 6% could not be verified. Key and Roland did not study the same articles after they were printed; however, they discuss the results of the study by Goodrich and Roland (1977) and surmise that "several of the journals they studied must have followed the practice of checking references; periodicals such as the Journal of Bone and Joint Surgery, with an error rate of 13%, compare highly favorably with journals such as JAMA, with a rate of 50%" (p. 137). Pandit's 1993 study of five library science journals includes an examination of the journal Library Trends whose editorial staff "verifies references against the original sources" (p. 193). Pandit found that, out of the 335 references examined, 177 (52.8%) contained errors at the manuscript stage, and just 14 (4.2%) errors were present in print. The presence of review staff who check references at the manuscript stage seems to significantly reduce the amount of errors present in print.

The types of citation errors found in the studies have also proven remarkably consistent. Studies by Poyer (1979), Benning and Speer (1993), Evans, Nadjari, and Burchell (1990), Eichorn and Yankauer (1987), Key and Roland (1977), Putterman and Lossos (1991), Stull, Christina, and Quinn (1991), Pope (1992), Hinchcliff, Bruce, Powers, and Kipp (1993), and George and Robbins (1994), showed that errors are most commonly found in authors' names. Errors in authors' names included misspellings and partial or total omissions in both surnames and initials. Errors in article titles, which included "paraphrasing or shortening of article titles" (Pope, 1992, p. 241), ranked second in most of these studies, an exception being Poyer's

(1979) study, which omitted article title verification from the study. Four studies (Doms, 1989; Goodrich and Roland, 1977; McLellan, Case, and Barnett, 1992; and Nuckles, Pope, and Adams, 1993) showed that article title errors were most common, followed by errors in authors' names. Two studies (de Lacey, Record, and Wade, 1985; and Evans, Nadjari, and Burchell, 1990) which did not rank types of errors numerically, revealed errors most often in article titles and authors' names. Studies by Pandit (1993) and Boyce and Banning (1979) revealed that most errors were numerical in nature, occurring in volume numbers, issue numbers, page numbers, etc. Thus, no real generalizations can be made regarding frequency of different types of errors between medical and library science literature; all types of journals seem to be prone to all types of errors.

Research Objectives and Hypothesis:

Since no bibliographical reference accuracy study had been done on the periodical literature in the field of entomology, this study examined five core entomology journals and attempted to answer the following research questions:

1. What percentage of citation errors typically occur in the most cited entomology periodical literature? Overall, are the references in these entomology journals more or less accurate than those in medical and library science journals?
2. What types of errors typically occur, and how do they compare with the results of other studies?
3. What types of publications do authors make the most mistakes in citing? Are book chapters, for example, more problematic for authors to cite than are regular journal articles?

Thirty-one percent is the combined average error rate of all the studies, in both

medical and library sciences, reported in the Literature Review section of this paper. How do entomology journals compare? The hypothesis of this study: that entomology journals have a 31% error rate as well.

A "correct", or "accurate", citation is defined as one in which all included elements are "identical to the source" (Doms, 1989, p. 442). "Errors," for the purposes of this study, are defined as "deviations from the source" (Doms, 1989, p. 442). Errors include both incorrect (including incomplete) and omitted (where it is required) citation information. An "article" is defined as a regular research article appearing in a journal issue, including "short communications" or "mini-reviews". "Types of publications," include cited journal articles and books, including government documents, dissertations, and conference proceedings. Patents are excluded due to a lack of a standard form of citation. It was assumed that some references would be impossible to verify, such as some conference proceedings, some dissertations, and all items "in press" at the time the references were published. It was assumed, however, that most references would be verifiable. Due to varying uses by previous studies quoted in the literature review, it should be noted that "citation" and "reference" are used interchangeably and are synonymous.

Methodology:

In order to answer the research questions and test the hypothesis, an exploratory, descriptive study was performed on five entomology journals. The type of data collected includes information on the bibliographical references found at the end of articles published in the five entomology journals. These references were examined for accuracy.

The journals chosen for this study were selected based upon their "impact" ranking in ISI's Science Citation Index Journal Citation Reports from 1992.

According to ISI, a "high impact" journal has the highest "average number of current citations to articles [the] journal published in the previous two years." The six entomology journals with the highest "impact factor" for 1992 include:

1. Annual Review of Entomology
2. Insect Biochemistry and Molecular Biology
3. Journal of Insect Physiology
4. Pesticide Biochemistry and Physiology
5. Archives of Insect Biochemistry
6. Ecological Entomology

The highest impact journal, Annual Review of Entomology, was excluded from this study due to its nature as an annual review periodical. Previous studies, upon which this study is based, did not examine annual periodicals, and the number of references in the annual publication would have been disproportionate to the other journal issues which were examined. Thus, the remaining five on the above list were selected for this study.

The sampling technique used is based upon previous studies of this nature (Poyer, 1979; Doms, 1989; Benning & Speer, 1993; Pope, 1992; Evans, Nadjari, and Burchell, 1990; Eichorn & Yankauer, 1987; Nuckles, Pope, and Adams, 1993). The first issue published in 1992 for each journal was studied, as these journal issues are representative of typical issues for these publications. Every reference at the end of each article in each issue was examined, excluding references designated "in press," (n=15) and patents (n=3). Book reviews and letters to the editor did not appear in the issues examined, and therefore were not studied. As in previous studies, each journal has a different publication frequency, each issue has a different amount of articles, and each article contains a different amount of references. Insect Biochemistry and Molecular Biology is published 8 times a year; Journal of Insect Physiology is published monthly; Pesticide Biochemistry and Physiology is published monthly except for April, August, and December; Archives of Insect

Biochemistry and Physiology is published monthly; and Ecological Entomology is published quarterly. Excluding references to patents and "in press" items, in the first 1992 issues, Insect Biochemistry and Molecular Biology contains 11 articles and 311 references, Journal of Insect Physiology contains 8 articles and 249 references, Pesticide Biochemistry and Physiology contains 10 articles and 245 references, Archives of Insect Biochemistry and Physiology contains 5 articles and 155 references, and Ecological Entomology contains 15 articles and 377 references, for a total of 1,337 references. The sampling technique might have introduced some error; for example, the January 1992 issues may have been, by chance, particularly "good" issues for these journals. However, the fact that an attempt has been made to examine each reference in each chosen issue, and not just a random sample of the citations in those issues, helps to improve reliability.

Types, or categories, of errors for this study were primarily based on Pandit's definitions (1993, p. 190). Author/editor errors are incorrect authors'/editors' names, including misspellings, omitted authors' names, and incorrect, reversed, or omitted initials. Paraphrased or incorrect titles of articles were counted as errors, including omissions or misspellings of words, and mistaken additions or omissions of plural forms of words. Incorrect book and journal titles were counted as errors. Incorrect, misspelled, or omitted publishers or places of publication for books were counted as errors. Incorrect or omitted volume numbers, page numbers, and years were also counted as errors. None of the journals require, or included, journal issue numbers or months in citations. Two of the journals, Archives of Insect Biochemistry and Physiology and Pesticide Biochemistry and Physiology require that authors note only the first page number of journal articles; end page numbers are not required. Also, none of the journals required series titles as part of book references; therefore, these were not recorded even if they were included. Citations

to books in a series were classified as "books" or "journals" depending upon how the author cited them. For example, a citation to an article from the series Methods in Enzymology was classified as a book citation if the author included the publisher and place information and constructed it like a book citation; it was classified as a journal citation if the author did not include the publisher and place information, and configured the citation like a journal citation.

Deviations from the journals' required styles were not generally counted as errors. For example, if a journal requires that contributors use Index Medicus journal title abbreviations, and an author made an error in abbreviation, this was not counted as an error unless the journal title was incorrect, or unless the abbreviation error made identification of the journal title difficult. An example of this is the frequent mistaken abbreviation for the journal Biochimica et Biophysica Acta as Biochem Biophys Acta. Correct Index Medicus abbreviation for this title is Biochim Biophys Acta (boldface emphasis added by the researcher). If any of the citation's elements, such as volume, year and pages, were out of the required order, this was not counted as an error (Key and Roland, 1977).

Out of each issue to be studied, two photocopies of the references at the end of each article were made. One photocopy was used as a record of the original set of references. Each reference was given a letter code to designate from which journal and which article the reference originates, and the references were numbered consecutively for each article. The second set of photocopies was used to cut out a copy of each reference, which was attached to an evaluation sheet (see appendix), and given the same code and consecutive number. These evaluation sheets were used to evaluate the accuracy of the reference, to keep track of references, and to compile the raw data into usable form. This instrument was field tested by following the procedure on a sample set of references at the end of one of the

articles in one of the journal issues examined for study. Missing elements were noted and included in a revised, final version of the evaluation sheet.

The references were compared with the original piece, or a photocopy or facsimile of the original piece, if possible. Errors were recorded specifically either as "incorrect or incomplete" or as an "omission." If the piece was checked out, a "hold" was placed on the item, which generally made the item available to the researcher within ten days. When the Ohio State University Libraries did not own the item, either the item itself or a photocopy of the item was obtained through interlibrary loan. If the item could not be obtained through interlibrary loan, then an attempt was made to verify the reference in indexes or databases. Due the the possibility that indexes and databases themselves may contain errors, an attempt was made to verify the references in two or more indexes or databases. If index or database verification was not possible, the reference was labeled "unverified." Some references were impossible to verify; these were some conference proceedings, some dissertations and rare, foreign-language publications unavailable through interlibrary loan, and some "unidentifiable" publications. These "unidentifiable" ones could not be found in any database. This made interlibrary borrowing impossible, as well as database or index verification. Any unverifiable references were counted in the total number of references examined, but were not considered errors, nor were they used to calculate error rates or percentages of errors. (See Table 1.)

The type of publication cited was also noted on the evaluation sheet, whether it was a book or book chapter, or a journal article. This was used to determine which of the two types of publications, books or journals, are most difficult for authors to cite correctly.

Table 1: Unverifiable Citations

Reason	Journal Title Abbreviation					Totals
	AP	EE	IB	JP	PB	
Conference proceedings	0	0	1	1	3	5
ILL unavailable - Dissertation	0	2	0	0	0	2
ILL unavailable - Regular	0	1	0	0	0	1
Unidentifiable	1	3	1	0	1	6
Totals	1	6	2	1	4	**14**

Key: AP=Archives of Insect Biochemistry and Physiology, EE=Ecological Entomology, IB=Insect Biochemistry and Molecular Biology, JP=Journal of Insect Physiology, PB=Pesticide Biochemistry and Physiology

Results and Discussion:

In the first issues in 1992 of the top five entomology journals, 518 errors, involving 398 citations, occurred in 1,323 verifiable citations. The overall error rate is 30%, slightly below the average error rate of 31%. This is not a statistically significant difference at the 0.05 level (t=0.21). The journal Ecological Entomology had the lowest percentage of errors and Insect Biochemistry and Molecular Biology the highest error rate of 35%. (See Table 2.)

Most of the citations (1,309 or 99%) were verified by comparing the citation to the original piece, or a photocopy or facsimile of the original piece obtained through interlibrary loan. The remaining 14 citations were verified in online databases or library catalogs. Ten of these were verified in two or more databases or catalogs; however, four of them were verified as being correct in only one database. Three of these four were dissertations, and the remaining one was a booklet published by a small, local park.

Most of the errors found in the entomology journals studied appeared in journal article titles. (See Table 3.) Thirty percent (n=157) of the 518 total errors found were journal article title errors. Most of these errors seem very minor; often, the plural form of a word in the title was used, or not used, by mistake. Words were omitted, added, misspelled. Sometimes scientific names were omitted. Errors in punctuation within phrases sometimes occurred. This seems very minor, and most of the time it causes few retrieval problems. However, consider the difference in meaning between these two phrases: "...ascorbate-free radical..." (found in an incorrect citation) versus "...ascorbate free-radical..." (found in original publication). A simple typing error in a seemingly small word can change the whole meaning of a phrase. Consider the difference in meaning between the following two article titles: "Delta-endotoxins **from** cation-selective channels..." (found in incorrect

Table 2: Entomology Journals Studied, Citations, and Errors

Journal Title	Total Citations	Total Verified	Total # Errors	Total Citations with error(s)	% Errors
Arch Insect Biochem Physiol	155	154	70	43	28%
Ecological Entomology	377	371	115	98	26%
Insect Biochem Molecular Biol	311	309	141	108	35%
Journal of Insect Physiology	249	248	109	80	32%
Pesticide Biochem Physiol	245	241	83	69	29%
Totals	1,337	1,323	518	398	**30%**

Table 3: Types of Citation Errors Found

	Arch Insect Bioch Phys		Ecological Entomol		Insect Biochem Mol Biol		Journ Insect Physiol		Pest Biochem Physiol		Totals			
	Incorr/Incplt	Omissions	Incorr/Incplt	Omissions	Incorr/Incplt	Omissions	Incorr/Incplt	Omissions	Incorr/Incplt	Omissions	Incorr/Incplt	% *	Omissions	% *
Journal Articles														
AU	30	7	22	0	47	1	31	0	16	1	146	28%	9	2%
TI	19	0	36	0	46	0	28	0	28	0	157	30%	0	0%
JO	0	0	8	0	5	1	4	0	1	0	18	3%	1	0%
VO	2	0	5	0	5	1	6	0	2	0	20	4%	1	0%
PG	3	0	11	0	12	1	7	0	2	0	35	7%	1	0%
YR	0	0	4	0	1	0	2	0	5	1	12	2%	1	0%
Subtotals	54	7	86	0	116	4	78	0	54	2	388	75%	13	3%
Books														
CA	0	0	1	0	3	0	5	3	0	0	9	2%	3	1%
CT	3	0	0	0	2	0	3	0	5	0	13	3%	0	0%
BA	3	0	6	3	7	0	7	0	4	0	27	5%	3	1%
BT	2	0	2	0	4	0	3	0	2	0	13	3%	0	0%
PL	0	0	1	7	1	1	0	0	0	2	2	0%	10	2%
PU	0	0	0	0	0	0	0	0	0	0	0	0%	0	0%
VO	0	1	0	1	0	1	0	3	0	3	0	0%	9	2%
PG	0	0	5	3	2	0	6	0	5	4	18	3%	7	1%
YR	0	0	0	0	0	0	1	0	1	1	2	0%	1	0%
Subtotals	8	1	15	14	19	2	25	6	17	10	84	16%	33	6%
Totals	62	8	101	14	135	6	103	6	71	12	472	91%	46	9%

* All percentages are % of total errors. Please note that apparent errors in the calculations of percentages are due to rounding.

Key: AU=Journal article author, TI=Journal article title, JO=Journal title, VO=Volume, PG=Pages, YR=Year, CA=Chapter author, CT=Chapter title, BA=Book author/editor, BT=Book title, PL=Place of publication, PU=Publisher.

citation) versus "Delta-endotoxins **form** cation-selective channels..." (found in original publication). Less often, article titles were paraphrased; this could cause delays when attempting to locate an article, by article title, online. An example of this is the incorrectly cited article title, "Interaction of fluridone with phytoene desaturase of *Aphanocapsa*." The correct version, found in the original publication, is, "Interference of fluridone with the desaturation of photoene by membranes of the cyanobacterium *Aphanocapsa*."

Errors in names of journal article authors was the second most frequently occurring error. Twenty-eight percent (n=146) of all 518 errors were journal article author name errors. These errors included omitted, reversed, or incorrect initials, and misspelled names. An example of the latter: "D. L. Coppage" was cited as "D. L. Coopage." Sometimes completely incorrect authors had been added to citations, however, this was relatively rare. As with some article title errors, these errors can impede location of an article, especially if a reader of a bibliography writes down or memorizes only the name of an author, with the intention of locating that article later. Omissions of article authors' names was very infrequent (n=9, 2%); however, the consequences are similar.

The third most frequent error found in this study, though much less frequent than journal article title or author errors, was page number errors. These errors occurred 35 times, and comprised 7% of all errors. Often, these errors seemed to be typographical errors, such as in the example of "389-389"; the correct page numbers were 381-389. The type of page number errors that were the most troublesome when attempting to locate an article were the ones given, for example, as "1185" instead of "1885." Incorrect/incomplete or omitted book chapter page numbers (n=18, 3% and n=7, 1%, respectively) can cause similar problems; however, it is often easier to look up pages to a book chapter in a table of contents than it is to look

up article pages in a journal's yearly index.

The fourth most common error occurred in book citations: incorrect or incomplete book authors' or editors' names (n=27, 5%). Like errors in article authors' names, these errors can cause problems when attempting to locate a publication in an online database or library catalog.

Incorrect or incomplete journal titles (n=18, 3%) or book titles (n=13, 3%), can cause serious problems when attempting to locate a journal or a book in a library catalog. A simple title-word reversal caused this problem; Journal of Medical and Veterinary Mycology was cited as Journal of Veterinary and Medical Mycology. A few times, the journal Nature was cited instead of the correct Science, and vice-versa. These two titles happened to be juxtaposed in the library used by the researcher, thus preventing these errors from becoming time-consuming. However, this error would have otherwise required the use of an index for verification. Another time-consuming title error was an incorrect citation of the 1986 book Proteinase Inhibitors as Protease Inhibitors.

Omission of the place of publication of books occurred ten times (2%). While this did not cause problems in locating the books if owned by the library, it could cause problems when attempting to order books. Another problematic error, which occurred 9 times (2%), was the omission of a volume number when a volume of a monographic set was cited. In every case, this required the time-consuming process of looking in the index to the monographic set.

Incorrect, incomplete, or omitted volumes and years in journal article citations did not cause time-consuming problems in this study, simply because these types of errors never occurred simultaneously in the same citation. However, both of these types of errors can cause problems for the reader of a bibliography who tends to memorize or write down one and not the other. Volume and year errors

can also cause problems when a journal is published in more than one volume per year.

Some types of errors occurred very infrequently; these include: journal title, volume, page, and year omissions, and book publication year omissions. Some types of errors did not occur at all. These were article title omissions, chapter title omissions, book publisher errors of both types, and incorrect book volumes. The reason for this seems to be the relative "obviousness" of this data. The one-time-each occurrence of the journal title, volume, page, and year omission seems to be a publisher's error, since they occurred in the same citation. The lines of type containing this information simply seem to have been mistakenly left out of where they belonged and placed at the end of another line of type, where they were later found.

The types of errors found in this study are very similar to the types of errors found in previous studies. Although seven previous studies found most mistakes in authors' names, four studies found that article titles contained the most errors, as this one did. (See Table 4.) In each case, mistakes in authors' names were the next most frequently occurring error, followed by mistakes in numerical citation data.

Although fewer books were cited than journal articles and most of the errors occurred in citations to journal articles, a greater percentage of citations to books contained errors than citations to journal articles. For example, in Insect Biochemistry and Molecular Biology a full 61% of citations to books contained one or more errors versus 32% of journal article citations. Archives of Insect Biochemistry and Physiology was the only exception in this comparison; only 21% of citations to books contained at least one error, compared to 29% of journal article citations. (See Table 5.) It is possible that the reason why citations to books more often contain one or more errors is because book citations often contain more

Table 4: **A Comparison of Citation Accuracy Studies**

Author	Subject Scope	Date	#Citations examined	Most errors in	% Errors
Benning & Speer	Library & Medical Sciences	1993	525	authors' names	29%
Boyce & Banning	Social Sciences	1979	1,012	numerical data	13%
de Lacey et al.	Medicine	1985	300	*	24%
Doms	Dentistry	1988	500	article titles	42%
Eichorn & Yankauer	Public Health	1987	150	authors' names	31%
Evans et al.	Surgery	1990	150	*	48%
Foreman & Kirchhoff	Nursing	1987	112	*	30%
George & Robbins	Dermatology	1994	240	authors' names	41%
Goldberg et al.	Emergency Medicine	1993	145	*	28%
Goodrich & Roland	Medicine	1977	2,195	article titles	29%
Hinchcliff et al.	Veterinary Medicine	1993	295	authors' names	30%
Kristof	**Entomology**	**1995**	**1,337**	**article titles**	**30%**
McLellan et al.	Anesthesiology	1992	348	article titles	50%
Nuckles et al.	Dentistry	1993	298	article titles	21%
Pandit	Library Science	1993	1,094	numerical data	18%
Pope	Library Science	1992	100	authors' names	30%
Poyer	General Sciences	1979	2,448	authors' names	15%
Putterman & Lossos	Medicine	1991	384	authors' names	33%
Stull et al.	Physical Education	1991	973	authors' names	47%
AVERAGE ERROR RATE FOR ALL STUDIES					**31%**

* Data not available from study.

Table 5: Comparison of Citations to Journal Articles with Citations to Books

	Verified	Containing Errors	% Errors
Archives Insect Biochemistry and Physiology			
Journal articles	130	38	29%
Books	24	5	21%
Ecological Entomology			
Journal articles	310	76	25%
Books	61	22	36%
Insect Biochemistry and Molecular Biology			
Journal articles	281	91	32%
Books	28	17	61%
Journal of Insect Physiology			
Journal articles	209	61	29%
Books	39	19	49%
Pesticide Biochemistry and Physiology			
Journal articles	201	49	24%
Books	40	20	50%
Average percentage of citations containing errors - journal articles			28%
Average percentage of citations containing errors - books			43%

bibliographic information or "elements" than journal citations. For example, if an author cites a chapter from a multi-volume set of books, nine minimum elements are needed in the citation: chapter author, chapter title, book editors, book title, place of publication, publisher, volume number, year, and page numbers. In contrast, when an author cites the entire book, only six elements are required, which is the same amount required for a journal article citation. The data seem to support this. Out of the 192 book citations in this study, 137 of them were citations to chapters within the books. Sixty-six (48%) of these contained one or more errors. However, of the 55 citations to entire books, proportionately fewer (17 or 31%) contained one or more errors. Another possible reason for this discrepancy is because books are simply cited less often than journals; authors get more practice with citing journal articles.

Out of the 49 articles in the five journal issues examined, only three articles had completely error-free reference lists. One error-free reference list each appeared in Journal of Insect Physiology, Insect Biochemistry and Molecular Biology, and Ecological Entomology. While, the researcher was unable to contact the editors of all the journals studied, the researcher spoke with an editor of Journal of Insect Physiology, who said that while reference lists were examined for content, each reference was not examined for accuracy. Judging from the similarity of errors and error patterns among these journals, it is likely that none of the editors of these five journals examines references for accuracy during the editorial process. Authors of previous studies have suggested that authors should be primarily responsible for the accuracy of their bibliographies, however, it has been noted also that editors, reviewers, or publishers should attempt to verify at least a small portion of the references in papers accepted for publication. Doms' suggestion that editors or editorial staff "make a policy of checking 10% the citations for each article as part of

the acceptance process" (1989, p. 444) still seems to be an idea worth implementing.

Significance:

Previous bibliographical citation accuracy studies have examined primarily medical and library science literature. Studies of the literature of other fields is lacking. This study was based, in part, upon previous studies of this nature. It is important to determine if bibliographical references in the literature of other fields is as error-ridden as the literature that has been studied thus far. This study also sought to determine what kind of publications authors make the most errors in citing.

This study examined the field of entomology only; there are many other fields that have yet to be examined, for example education and other social sciences. Further studies of this sort might survey editorial boards of journals to find out if any amount of references are verified before publication. Also, further studies might attempt to find out whether or not there is a correlation between citation information printed on the first page or all pages of the cited article and citation accuracy. Further studies might also examine the different types of article title or author name errors in greater detail to try to determine if any patterns appear that could shed some light on why these errors continue to be the most frequent.

Bibliographical references are used for many purposes, such as document delivery, document location, bibliometric and citation studies, and evaluation of an author's work. Accurate references facilitate all of these activities. Accurate references demonstrate the kind of attention to detail that should be a part of every scholar's research.

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